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Department of
Agriculture
**Forest
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Southwestern
Region

Forest Pest Management Report

R-3 84-4

BIOLOGICAL EVALUATION
Western Spruce Budworm

Carson National Forest
New Mexico

December 1983

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USDA Forest Service, Southwestern Region
State and Private Forestry
Forest Pest Management
517 Gold Avenue, SW
Albuquerque, New Mexico 87102

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ABSTRACT

Infestations of western spruce budworm, Choristoneura occidentalis Free., continued to occur on both divisions of the Carson National Forest, the Taos Pueblo Indian lands, and adjoining lands of mixed ownership. Total acres of host type defoliated declined slightly from 114,450 acres in 1982 to 100,700 acres in 1983. Aerially observed defoliation to mixed conifer stands decreased substantially on both the Taos and Questa entomological units; however, new areas of defoliation were aerially detected along the Rio Chiquito drainage on the Taos unit and in the Rincon Mountains on the Penasco Ranger District. This is the first recorded incidence of aerially observed budworm defoliation on the Penasco Ranger District in recent times. Several new pockets of defoliation were also detected on the Tres Piedras entomological unit, Canjilon Ranger District, and Jicarilla Apache Indian Reservation.

Egg mass densities sampled on the Taos and Questa entomological units remained relatively high, averaging 26.3 and 16.7, respectively. These data indicate that defoliation will continue to occur at light to moderate levels in 1984. Defoliation will be most noticeable along the Rio Fernando de Taos drainage from Capulin Canyon to Palo Flechado Pass on the Taos entomological unit and along Cabresto Creek and State Highway #38 from Questa to Red River on the Questa entomological unit. Pockets of mortality were observed on these units in 1983; the cause of this mortality is thought to be due to a combination of several years of severe budworm defoliation, bark beetle attacks, and/or dwarf mistletoe and root diseases. However, no significant increases in mortality are expected to occur on these units in 1984.

Egg mass densities on the Tres Piedras entomological unit were variable, and averaged 3.0 in areas treated with carbaryl in 1983 and 29.4 in areas west of the treatment areas; egg mass densities on the El Rito entomological unit averaged 42.6. These data show that budworm infestations and defoliation can be expected to increase in areas west of the 1983 suppression project treatment areas and throughout the host type on the Tres Piedras and El Rito entomological units, respectively, in 1984.

Pest management alternatives and recommendations are presented and discussed in this report.

INTRODUCTION

The western spruce budworm (WSBW), Choristoneura occidentalis Free. continued to cause extensive defoliation to spruce, Douglas-fir, and true firs on the Carson National Forest (NF) in 1983. Visible[1] defoliation was first observed on the Taos and Questa entomological units in 1975 and 1976, respectively. Defoliation was aerially detected on the Tres Piedras and El Rito[2] entomological units in 1980 and on the

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[1] Visible defoliation based on the aerial detection survey.

[2] Formerly included as part of the Tres Piedras entomological unit from 1980 to 1981.

Canjilon Ranger District (RD) and Jicarilla Indian Reservation (IR) in 1982. Since 1976, total acres defoliated on the Forest and adjoining lands were 21,760 in 1976; 40,200 in 1977; 15,039 in 1978; 30,542 in 1979; 108,450 in 1980, 135,025 in 1981; 114,450 in 1982; and 100,700 in 1983.

Egg mass sample data were collected from the Taos, Questa, Tres Piedras, and El Rito entomological units. These data are summarized in this evaluation. Management alternatives and recommendations are also presented.

TECHNICAL INFORMATION

Insect. Western spruce budworm, Choristoneura occidentalis Freeman

Hosts. Douglas-fir, Pseudotsuga menziesii (Mirb.) Franco
White fir, Abies concolor (Gord. & Glend.) Lindl.
Subalpine fir, Abies lasiocarpa (Hook.) Nutt.
Blue spruce, Picea pungens Engelm.
Engelmann spruce, Picea engelmannii Parry

Life History. The western spruce budworm completes one generation each year (Furniss and Carolin 1977).

Stage	Time	Location on host
Egg	August	On needles
Small larvae	Overwinter	In hibernaculum (silken cocoons) on branches and trunk
Large larvae	June	On buds and strobile
Pupae	July	On foliage
Adults	August	In flight

Evidence of Infestation

1. Young larvae feeding on newly expanding buds and strobile.

2. Mature larvae consuming current year's needles.

3. Shoots webbed together by larvae.

4. Webbed shoots turning brown and falling from trees.

5. Defoliation most evident in upper crowns of trees.

6. Trees dying from the top downward after several years of heavy defoliation.

Extent of Defoliation in 1983. Defoliation was visible from the air on approximately 100,700 acres of the Carson NF and adjoining lands.

Severity of defoliation was categorized as: Light, 43,650 acres; moderate, 55,175 acres; and heavy, 1,875 acres. Defoliation by separate ownerships is as follows:

	Defoliation			
	Light	Moderate	Heavy	Total
Carson NF	38,400	51,175	1,500	91,075
Taos Pueblo IR	2,675	1,100	50	3,825
Jicarilla IR	0	675	325	1,000
Other adjoining land	2,575	2,225	0	4,800

Total acres of aerially observed defoliation decreased substantially on both the Taos and Questa entomological units in 1983. Defoliation on the Taos unit (figure 1) continued at light to moderate levels along both sides of the Rio Fernando de Taos drainage from Ranchos Canyon eastward to Palo Flechado Pass and from Osha Pass south to Osha Mountain. New areas of light to moderate defoliation were detected along the Rio Chiquito drainage north of Osha Park and northwest of the Rincon Mountains along the Taos-Penasco District boundary (figure 1). This is the first reported observation of budworm defoliation aerially observed on the Penasco RD in recent times.

Visible defoliation on the Questa entomological unit (figure 2) decreased significantly in 1983. Defoliation on this unit was light to moderate and primarily occurred north and south of Cabresto Creek, west of Mallette Creek, and southwest and southeast of Red River (figure 2). Small pockets of budworm defoliation were also observed north of Kiowa village and west of Twining, near the Taos ski area.

Budworm defoliation on the Tres Piedras and El Rito entomological units, on the other hand, continued to increase in area and intensity during 1983. On the Tres Piedras entomological unit, defoliation in areas treated with carbaryl in 1982 and 1983 was, for the most part, undetectable; however, several pockets of light to moderate defoliation were detected south of Valle Grande between the Little Tusas River and Duran Canyon (figure 3). This area was treated with a combination of carbaryl and the bacterium, Bacillus thuringiensis Berliner, in 1983. Light to moderate defoliation was also detected for the first time throughout the remainder of the untreated host type from Burned Mountain north to Lagunitas Spring (northern most boundary) (figure 3). On the El Rito unit, defoliation was observed throughout the Douglas-fir, true fir, and spruce type. Defoliation was moderate to heavy along the southwestern boundary of the infestation and light to moderate between the El Rito River on the west and the Rio Vallecitos on the east (figure 4).

Defoliation on the Canjilon RD and the Jicarilla Apache IR also increased. Several new areas of light to moderate defoliation were detected in both areas (figures 5 and 6).

BIOLOGICAL INFORMATION

Egg mass surveys were conducted in August and September 1983 to provide an indication of larval density and defoliation trends expected to occur in 1984. Egg mass samples were collected from a total of 89 plots from the following entomological units: Taos (28 plots); Questa (11 plots); El Rito (10 plots); and Tres Piedras (40 plots). Two branches (70 cm in length) were cut from opposite sides of the mid-crown of three sample trees on each plot. Sample trees met the following criteria: Douglas-fir, dominant or codominant; 30 to 50 feet in height; relatively open grown with a full crown; and some budworm feeding evident, but the tree could not be severely defoliated or top-killed. Branches were bagged in ¼-bushel cloth bags, tied, labeled, and transported to the laboratory for examination. All bagged samples were stored in a walk-in cooler set at 40° F.

In the laboratory, the foliage was examined under ultraviolet light for budworm egg masses. Needles bearing egg masses were classed as from current year's foliage, or previous year's foliage, and kept separate in labeled pill boxes and later identified as new or old. All egg masses on current year's foliage were classed as new, and their characteristics formed the basis for aging egg masses found on previous year's foliage.

Defoliation projections for 1984 were determined from the density of 1983 egg masses using the following information presented by McKnight et al. (1970):

Egg mass density[a]	Predicted defoliation class[b]
<1.55	Undetectable for all infestations
1.71 to 6.20	Undetectable for "static" infestations Light for "increasing" infestations
9.30 to 31	Light for "static" infestations Moderate for "increasing" infestations
>34.10	Moderate for "static" infestations Heavy for "increasing" infestations

[a] Number of egg masses per square meter of foliage.
[b] Defoliation class limits (percent of new growth).
Undetectable = <5 percent
Light = 5 to 35 percent
Moderate = 35 to 65 percent
Heavy = >65 percent

RESULTS AND PREDICTION OF TREND

Results of the 1983 egg mass survey conducted on the Carson NF are presented and discussed by entomological unit and are summarized in table 1.

Taos Entomological Unit. This unit includes the Taos RD, Taos Indian Pueblo lands, and adjoining private lands. The overall average egg

mass density for this unit[3] increased from 17.2 (1982) to 26.3 (1983) egg masses per square meter of foliage. Average egg mass densities for specific areas sampled ranged from lows of 7.9 and 10.6 in La Jara Canyon and along the Rio Chiquito drainage, respectively, to a high of 57.5 in Capulin Canyon. Elsewhere, egg mass densities averaged 32.7 (along FS Road 437 leading to Garcia Park), 21.3 (Palo Flechado Pass), and 27.8 (along FS Road 76 leading to Osha Mountain).

These egg mass density data indicate that defoliation to new foliage growth on the Taos entomological unit will continue to occur at light to moderate levels again in 1984. Defoliation will continue to be most noticeable along the Rio Fernando de Taos drainage from Capulin Canyon east to Valle Escondido and from Palo Flechado Pass south to Osha Mountain. Recently detected budworm infestations and defoliation in areas along and south of the Rio Chiquito drainage (figure 1) are also expected to continue and may increase in both area and intensity again in 1984.

Pockets of mortality consisting of Douglas-fir, true firs, and spruce were conspicuous along the Rio Fernando de Taos drainage (figure 1). Observed mortality occurred primarily along the steep, north-facing slopes. Preliminary observations indicate that the observed mortality may be due to a combination of several consecutive years of severe budworm defoliation, bark beetle attacks, and/or dwarf mistletoe and root diseases.

Questa Entomological Unit. This unit includes the Questa RD and adjoining private lands. The average egg mass density for this entomological unit decreased from 26.3 in 1982 to 16.7 in 1983. Individual sample plot egg mass densities ranged from 15.7 to 20.1 in Cabresto Canyon and from 3.1 to 15.1 in the Rio Hondo drainage west of Twining, near the Taos ski area.

Defoliation on this unit is expected to continue at levels similar to those experienced in 1983. Budworm defoliation will continue to be most conspicuous along Cabresto and Bontio Canyons (north of State Highway 38), along State Highway 38 from Questa to Red River, and along the upper portions of Hondo Canyon, just west of Twining and the Taos ski area (figure 2).

Large areas of dead tops and tree mortality were observed in several drainages along State Highway 38 (figure 2). These damages are thought to be a result of a combination of several years of severe budworm defoliation, bark beetle attacks, and/or dwarf mistletoe and root diseases.

Tres Piedras Entomological Unit.[4] This unit includes the Tres Piedras RD, the northeast corner of the El Rito RD from State Highway 110 east

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[3] Egg masses for the Taos entomological unit were collected on the Taos RD.

[4] This entomological unit formerly included the entire El Rito RD.

to Posos Lake (Kiowa Mountain and immediate surrounding area), and adjoining private lands. Egg mass densities on this entomological unit were highly variable. In areas successfully treated with carbaryl during the recent 1983 WSBW project, individual sample plot egg mass densities ranged from 0.7 to 5.4 and averaged 3.0 for the treatment area as a whole. In areas treated during the 1982 WSBW project, average egg mass densities increased from 5.7 in 1982 to 17.5 in 1983. However, since only a few areas were sampled near Kiowa Mountain and along Cunningham Gulch, this average, although showing an increasing trend, may not be representative of the entire 1982 treatment area. Elsewhere, in areas where defoliation was aerially detected for the first time in 1983 (figure 3), egg mass densities ranged from 10.8 on Burned Mountain to 33.5 south of Hopewell Lake and 32.4 along the Rio Nutritas and FS Road 87, just north of Rio Nutritas.

These average egg mass densities suggest that defoliation on this unit in 1984 will be variable. For example, in areas treated with carbaryl in 1982 and 1983, defoliation is expected to continue at negligible levels in 1984. However, where wet foliage and/or application problems reduced efficacy (upper Maquinita, upper Duran, and upper Rock Creek drainages in 1982, and the Valle Grande area in 1983), defoliation may be light to moderate. Budworm defoliation is also expected to continue at light to moderate levels west of the 1982 and 1983 suppression project boundaries where defoliation was aerially detected for the first time in recent years in July 1983 (figure 3).

El Rito Entomological Unit.[5] This unit includes the El Rito RD and adjoining private lands, excluding Kiowa Mountain and its adjacent private ownerships. The average egg mass densities for this unit increased from 18.6 (1982) to 42.6 (1983) egg masses per square meter of foliage. Individual sample plot densities ranged from 23.6 to 66.7. Specific areas sampled were located along FS Roads 123 and 172.

Because of the relatively large increase in egg mass densities on this unit, budworm infestations and defoliation are expected to increase in intensity throughout the host type in 1984.

MANAGEMENT ALTERNATIVES

Management alternatives available to forest managers for the current WSBW outbreaks consist of primarily two courses of action: (1) No action or (2) suppression with one or a combination of pesticides currently registered by the U.S. Environmental Protection Agency (EPA). A discussion of these management objectives follow.

No Action. With this approach, the outbreak would be allowed to run its course until a population collapse occurred from a combination of: (a) A lack of foliage to maintain a larval population; (b) unfavorable

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[5] Formerly was included as part of the Tres Piedras entomological unit.

weather conditions; (c) heavy predation and parasitism; and (d) a microbial epizootic. Adverse and beneficial effects of the outbreak would have to be accepted. These are:

1. This alternative would not be effective in preventing additional tree damages. Impacts to resource values and uses caused by the budworm would have to be accepted under this alternative. Although damages resulting from the WSBW in the Southwest are not completely known, damages similar to those estimated for the Pacific Northwest could occur if the outbreak continues unabated. These include the following:

Tree damages	Maximum damages (percent)
Growth loss	30
Understory mortality	25
Sawtimber mortality	5
Top-killing	25
Cone crop reduction	90+
Christmas tree quality loss	90+

2. The costs of this alternative will be the dollar value of timber damaged. Also, the depletion of the understory could necessitate the expenditure of funds for reforestation.

3. Visual qualities and economic and social impacts would continue if this alternative were selected.

Direct Suppression. Aerial application of a pesticide registered by the EPA could suppress all or part of the outbreak on the Forest. However, if only part of the infestation is treated or if adjoining lands are not treated, one or two additional treatments may be required during the infestation cycle, since treated stands could be reinfested from nearby untreated areas.

Application would be carefully timed to the development of the larvae and bud flush; i.e., when 20 percent of the larvae are in the fifth and sixth instars and buds are 85 to 90 percent flushed. This would insure maximum effectiveness with a minimum dosage of insecticide. An application of this type is designed to utilize indigenous natural control agents to further reduce and maintain the budworm population at a low level.

Effects of this alternative are:

1. If a direct suppression program were to be carried out on the Forest in 1983, tree damages and losses could be reduced in areas where permanent tree damages have not yet occurred. However, once permanent tree damages have occurred, the direct suppression alternative may no longer be practical or economical.

2. Proper use of insecticides will not pose a significant hazard to humans, wildlife, or the environment.

Insecticides registered for use against the budworm follow:

1. Carbaryl (carbamate insecticide)

The Sevin 4 oil formulation of carbaryl has given consistently satisfactory results in suppressing budworm outbreaks throughout the West. An outbreak on the Santa Fe NF, New Mexico, was successfully suppressed in 1977, and the outbreak has remained at a low level for 5 years (Telfer, Ragenovich, and Rogers 1982). Carbaryl is a nonpersistent pesticide which is available for general use. One pound of active ingredient per acre is the registered dosage rate, and no lasting environmental effects have been identified at this application rate.

2. Acephate (organophosphate insecticide)

Orthene is a nonpersistent insecticide registered for use against the WSBW and other forest defoliators. Although this insecticide has been shown to be effective against the budworm, it has never been used in the Southwest. Without further pilot testing in the Southwest, its use is not recommended.

3. Malathion (organophosphate insecticide)

Malathion is a nonpersistent, broad-spectrum insecticide, registered for use against more than 100 insects, including the WSBW. However, it is not recommended because it has yielded inconsistent results in suppressing outbreaks.

4. Mexacarbate (carbamate insecticide)

Mexacarbate (Zectran) is a nonpersistent pesticide which is available for use against the WSBW. Mexacarbate is applied at a rate of 0.15 pounds of active ingredient per acre. No lasting environmental effects have been identified when properly applied at this rate. For use in the Southwest, mexacarbate requires additional pilot testing before it can be recommended for operational use.

5. Microbial Insecticides

Bacillus thuringiensis (B.t.), a bacterium, has been used experimentally and operationally in the Southwest. B.t. has adequately reduced WSBW populations, although results are sometimes inconsistent. Continued improvement of B.t. formulations has shown promise in increasing the insecticide's efficacy. However, it is recommended that current formulations be used only in sensitive areas (for example, populated areas and stream courses) where the use of chemical insecticides would unacceptable.

RECOMMENDATIONS

Management of Current Western Spruce Budworm Outbreaks

The recommended course of action for the majority of the WSBW infestations on the Taos entomological unit and for all of the infestations on the Questa and El Rito entomological units is "No Action." "Direct Suppression" of the entire outbreak on these units is no longer practical or economical, since permanent tree damages have already begun to occur throughout most of the infested host type on these units.

Direct suppression on the Taos entomological unit, however, is recommended for WSBW infestations along the Rio Chiquito drainage. Infestations in this drainage are relatively new and permanent tree damages have not yet occurred; however, permanent tree damages could occur within a year on two if the infestation continues to build up.

"Direct Suppression" is also recommended for infestations on the Tres Piedras entomological unit not previously treated in 1982 and 1983. Infestations on these areas are relatively new and permanent tree damages have not yet occurred; however, permanent tree damages could occur within a year or two if the infestations continue at present or increased levels. Once permanent tree damages occur, direct suppression may no longer be a viable alternative and all damages occurring would have to be accepted. Also, direct suppression of areas not previously treated on the Tres Piedras unit would maintain the integrity of areas previously treated and further reduce the possibility of population buildups from adjacent untreated areas. The majority of the infested areas should be treated with chemcial pesticides and sensitive areas with B.t.

Management of Mixed Conifer Stands to Prevent and/or Minimize Impacts of Future WSBW Outbreaks.

This approach consists of the silvicultural manipulation of the mixed conifer type to create stand conditions that reduce the impact of future infestations. Specifically, silvicultural prescriptions for mixed conifer stands should emphasize "state-of-the-art" strategies for reducing stand budworm susceptibility/vulnerability. These strategies include: (a) Regeneration cuts designed to create a mosaic of more even-aged stands, with a lower percentage of true fir; (b) regeneration cuts with artifical regeneration of nonhost tree species; and (c) intermediate cuts, such as thinning, improvement, and sanitation, to increase stand vigor, regulate stocking, and favor nonhost tree species.

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Telfer, William G., Iral R. Ragenovich, and T. J. Rogers. 1982. Western spruce budworm suppression and evaluation project using carbaryl-1977. USDA Forest Serv., Progress Rep. No. 5. R-3 82-7. 18 pp.

TABLE 1.--Summary of the egg mass and aerial detection surveys on the Taos, Questa, Tres Piedras, and El Rito entomological units

Taos entomological unit		1976	1977	1978	1979	1980	1981	1982	1983
New egg masses/ square m foliage		38.3	22.3	36.3	42.8	50.6	14.1	17.2	26.3
Egg mass density ratio[a]		1.7:1	0.6:1	1.6:1	1.2:1	1.2:1	0.3:1	1.2:1	1.5:1
Actual defoliation[b] (acres)	L	9,400	15,040	2,725	6,477	31,200	6,375	7,175	18,500
	M	6,600	10,800	2,790	9,191	26,750	41,125	18,550	6,825
	H	560	0	4,250	282	6,975	15,775	3,375	50
	TOTAL	16,560	25,840	9,765	15,950	64,925	63,275	29,100	25,375

Questa entomological unit									
New egg masses/ square m foliage			9.9	17.9	43.1	47.6	31.3	26.3	16.7
Egg mass density ratio[a]			3.4:1	1.7:1	2.4:1	1.1:1	0.7:1	0.8:1	0.6:1
Actual defoliation[b] (acres)	L	1,900	13,080	2,560	3,174	22,850	4,800	2,025	7,625
	M	300	960	2,330	5,197	15,550	39,700	8,550	1,975
	H	0	320	384	6,221	3,275	18,550	36,400	175
	TOTAL	2,200	14,360	5,274	14,592	41,675	63,050	46,975	9,775

TABLE 1.--Summary of the egg mass and aerial detection surveys on the Taos, Questa, Tres Piedras, and El Rito entomological units--Continued

Tres Piedras entomological unit		1980[c]	1981[d]	1982	1983
New egg masses/ square m foliage		1.8	35.0	6.8	22.3
Egg mass density ratio[a]			19.4:1	0.2:1	3.3:1
Actual defoliation[b] (acres)	L	550	5,650	2,625	8,800
	M	0	50	1,725	9,650
	H	0	0	0	50
TOTAL		550	5,700	4,350	18,500

El Rito entomological unit					
New egg masses/ square m foliage		29.7	33.5	18.6	42.6
Egg mass density ratio[a]			1.1:1	0.5:1	2.3:1
Actual defoliation[b] (acres)	L	325	1,700	20,275	7,225
	M	900	1,100	13,075	35,350
	H	75	200	600	1,275
TOTAL		1,300	3,000	33,950	43,850

[a] Egg mass density ratio is the ratio of new egg masses in the survey year to new egg masses of the previous year.
[b] Actural defoliation as determined from aerial detection survey; L = light, M = moderate, H = heavy.
[c] Data obtained from report R-3 81-4.
[d] Data previously combined under Tres Piedras entomological unit in 1981.

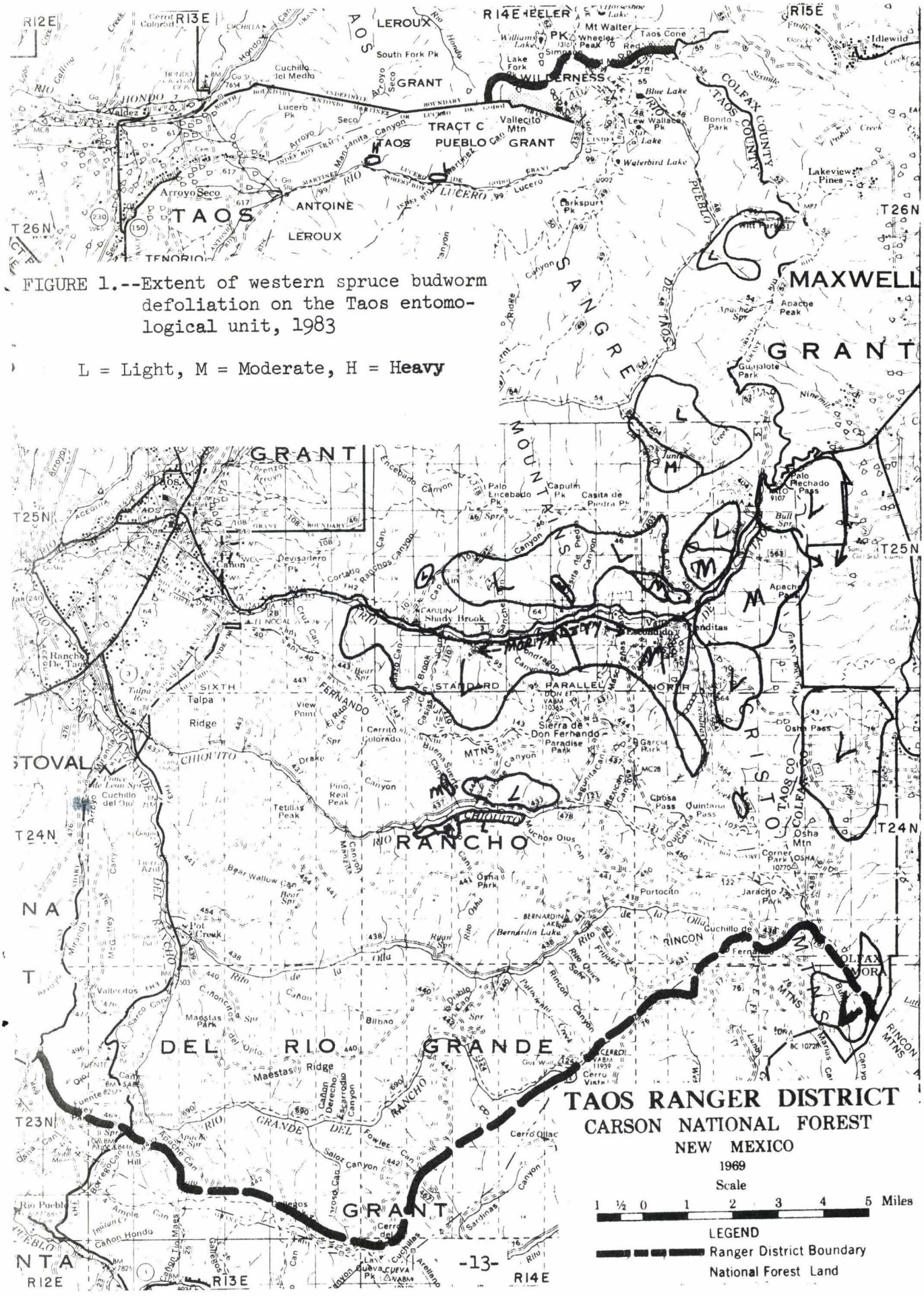
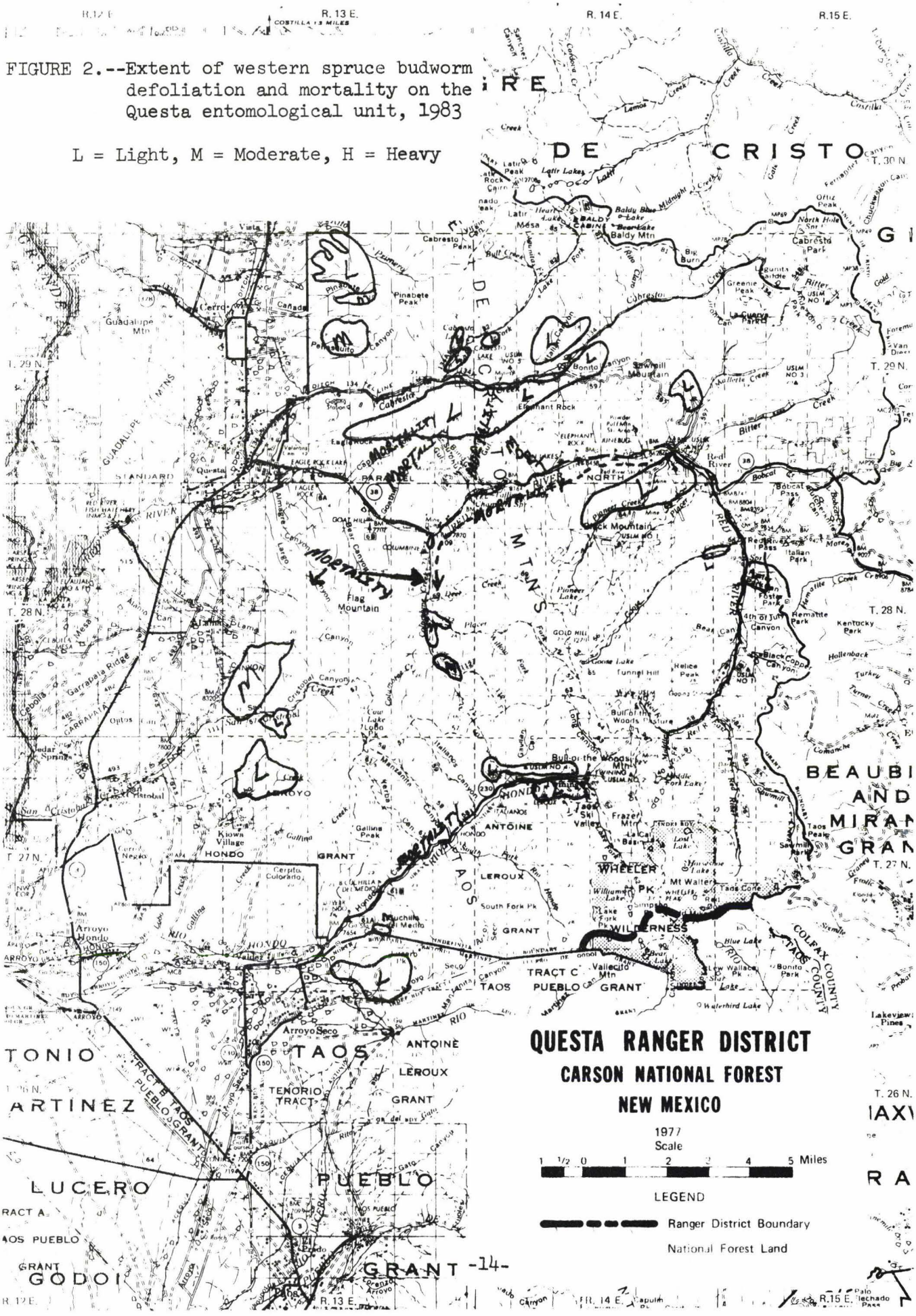


FIGURE 1.--Extent of western spruce budworm defoliation on the Taos entomological unit, 1983

L = Light, M = Moderate, H = Heavy

FIGURE 2.--Extent of western spruce budworm defoliation and mortality on the Questa entomological unit, 1983

L = Light, M = Moderate, H = Heavy



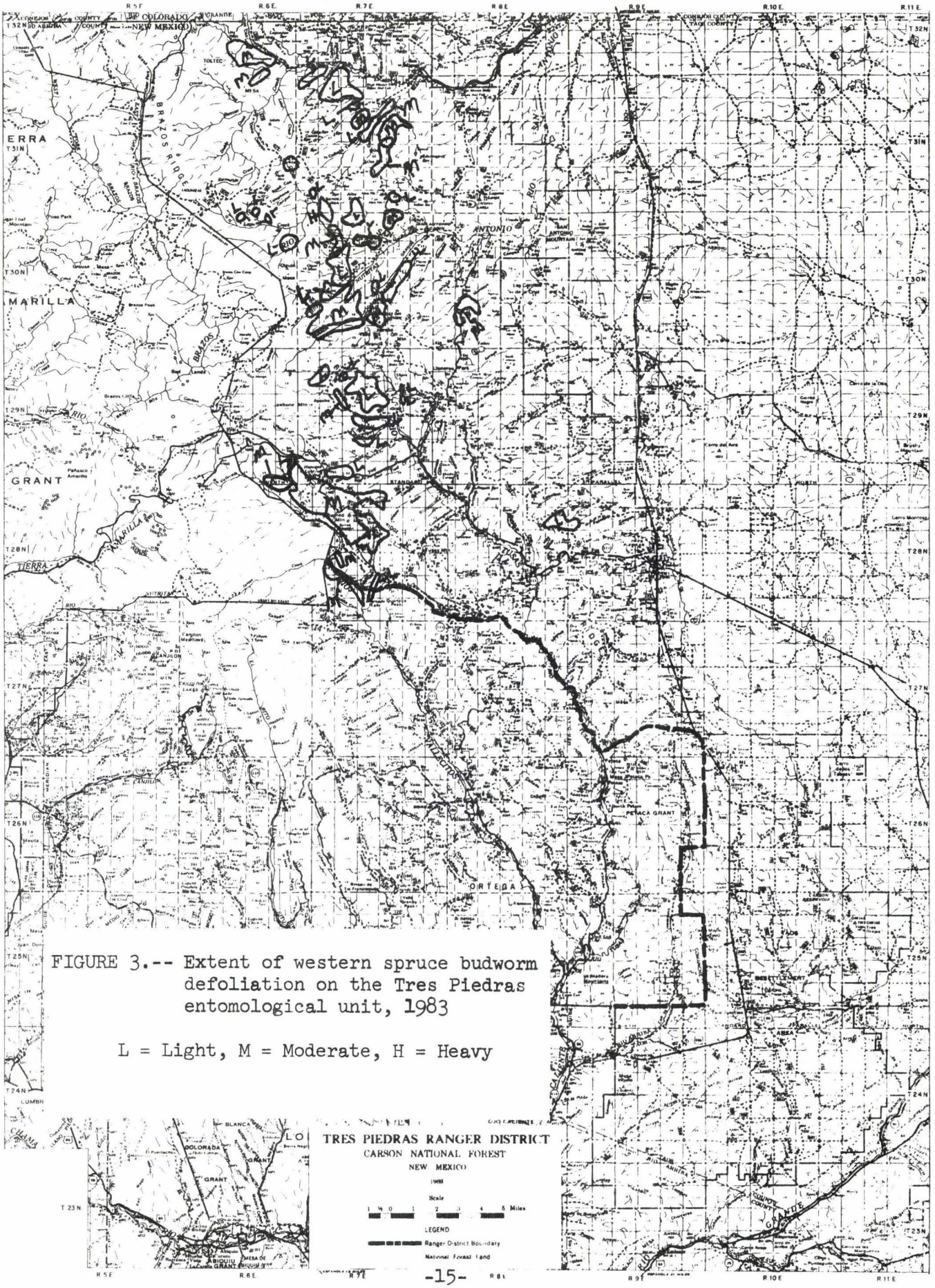


FIGURE 3.-- Extent of western spruce budworm defoliation on the Tres Piedras entomological unit, 1983

L = Light, M = Moderate, H = Heavy

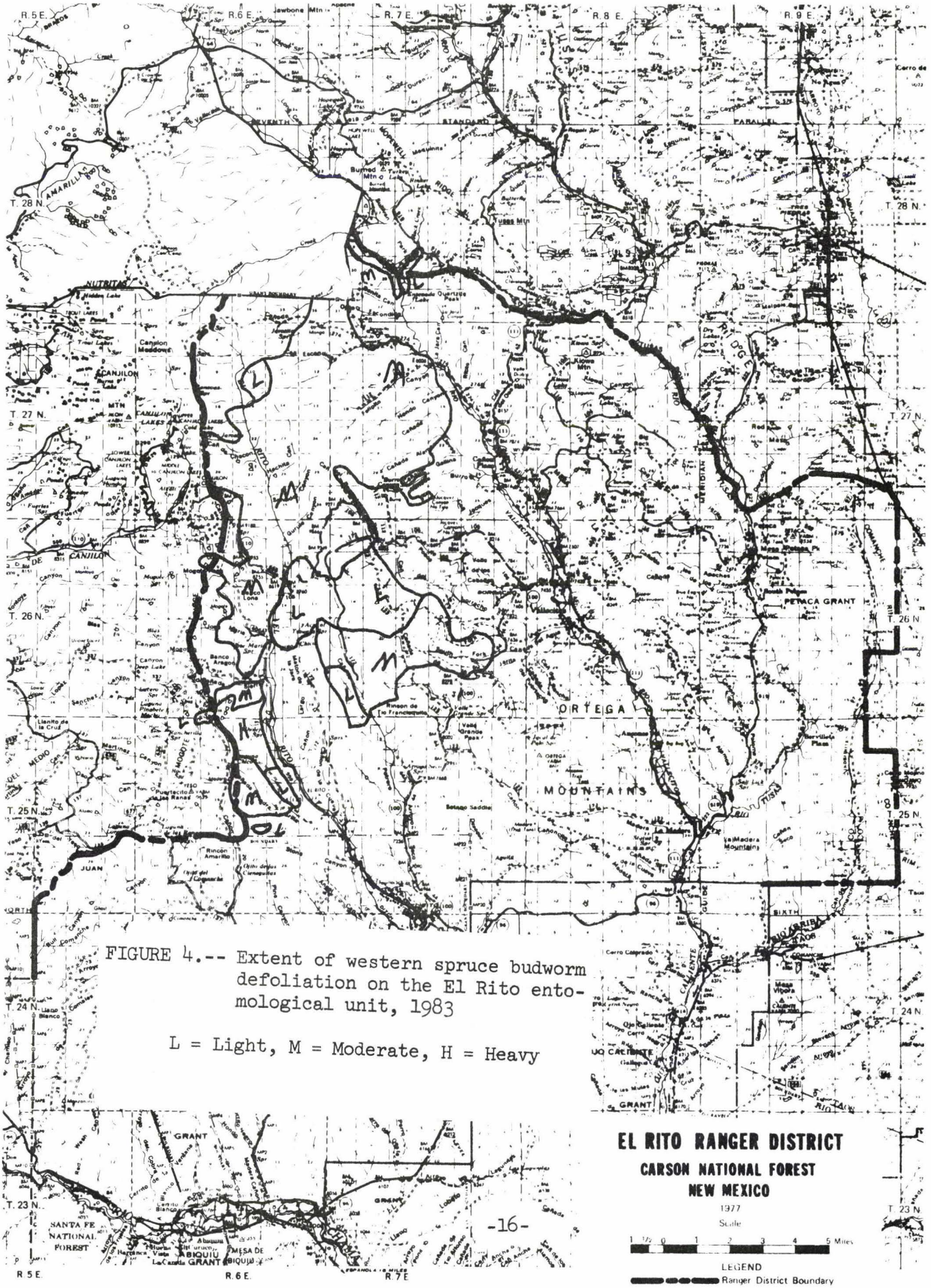


FIGURE 4.-- Extent of western spruce budworm defoliation on the El Rito entomological unit, 1983

L = Light, M = Moderate, H = Heavy

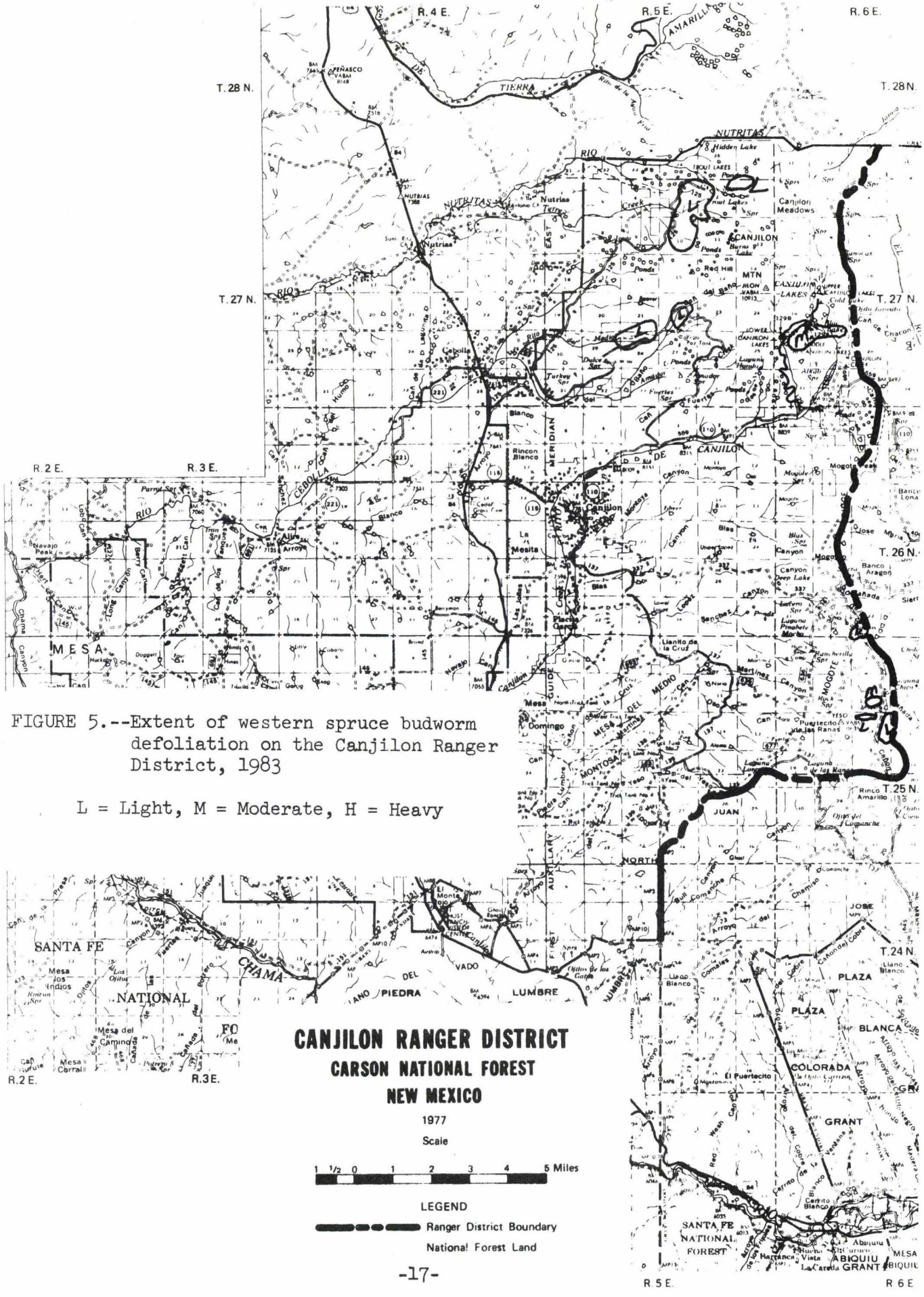


FIGURE 5.--Extent of western spruce budworm defoliation on the Canjilon Ranger District, 1983

L = Light, M = Moderate, H = Heavy

CANJILON RANGER DISTRICT
CARSON NATIONAL FOREST
NEW MEXICO

1977

Scale

1 1/2 0 1 2 3 4 5 Miles

LEGEND

Ranger District Boundary

National Forest Land

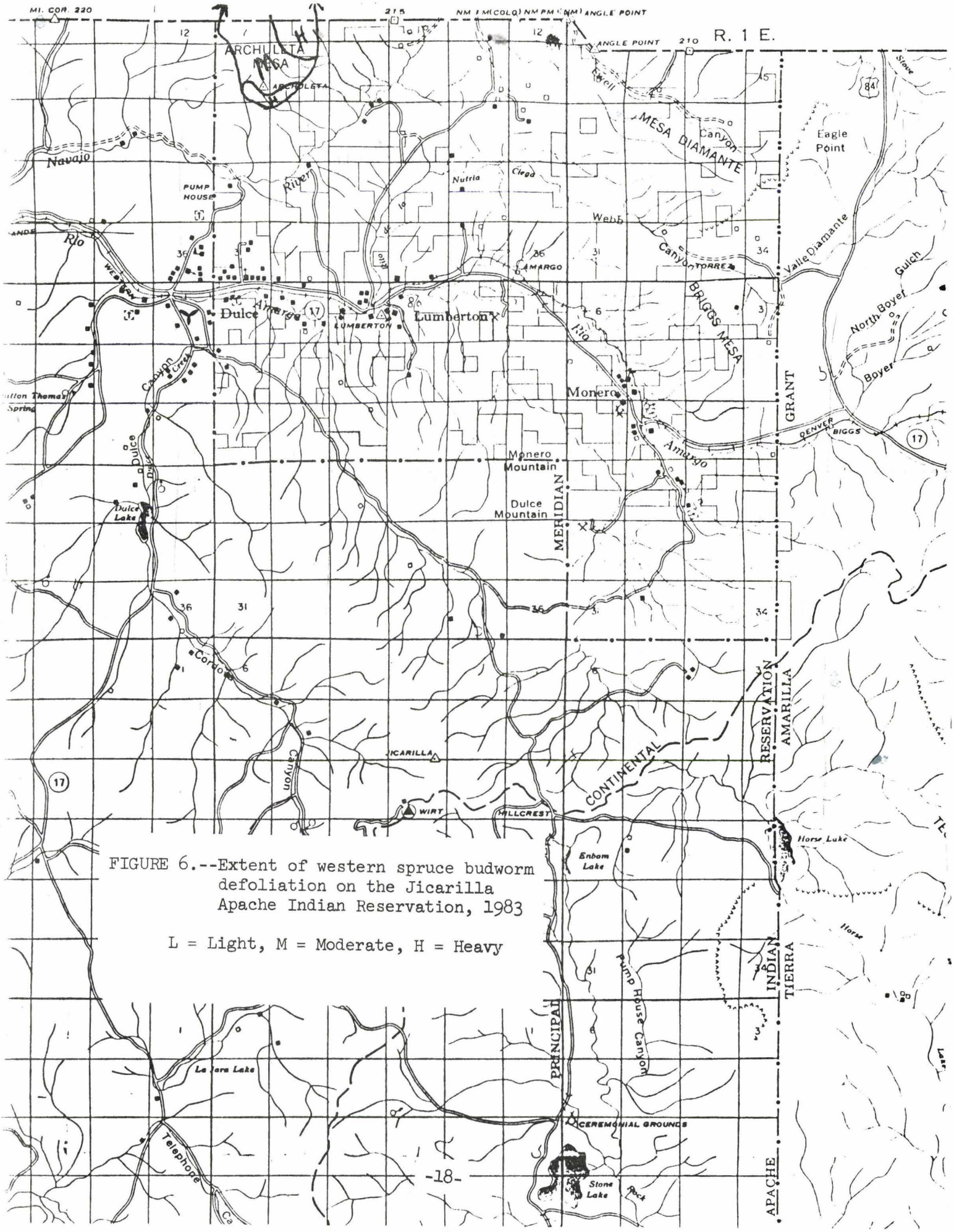


FIGURE 6.--Extent of western spruce budworm defoliation on the Jicarilla Apache Indian Reservation, 1983

L = Light, M = Moderate, H = Heavy